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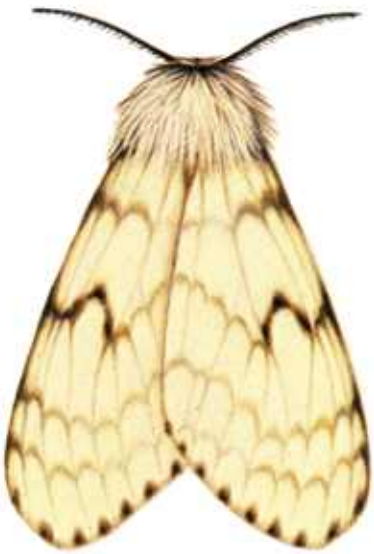
Technological Developments in Aerial Spraying



Technological Developments in Aerial Spraying

by
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In 1974 the U.S. Department of Agriculture initiated the Combined Forest Pest Research and Development Program, an interagency effort that concentrated on the Douglas-fir tussock moth in the West, on the southern pine beetle in the South, and on the gypsy moth in the Northeast. The work reported in this publication was funded in whole or in part by the program. This manual is one in a series on the gypsy moth.

Introduction

One aspect of the Expanded Gypsy Moth Research and Development Program was to conduct field and pilot tests of new pesticides. Coincidental with this pesticide research were the design and testing of technological improvements in both the support and evaluation phases of aerial spraying.

From previous experience with aerial spraying, research personnel recognized the need for an efficient, transportable mixing system for pesticides at the loading site; good communication among all participants in the field and on the ground; and an inexpensive, efficient method for recording the effects of experimental forest pesticides.

This booklet discusses a trailer-mounted pesticide mixing system, a radio communication network, and an aircraft camera mount for small-format photographic equipment, all of which were designed and tested by research personnel. Specifications for any of these systems may be obtained from the Forest Service, 151 Sanford St., Hamden, Conn. 06514.

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A Trailer-Mounted Pesticide Mixing System

Ground support mixing equipment rented on contract is expensive and frequently unable to meet the special needs of experimental pesticide programs. To solve this problem, specialists designed a trailer-mounted pesticide mixing system.

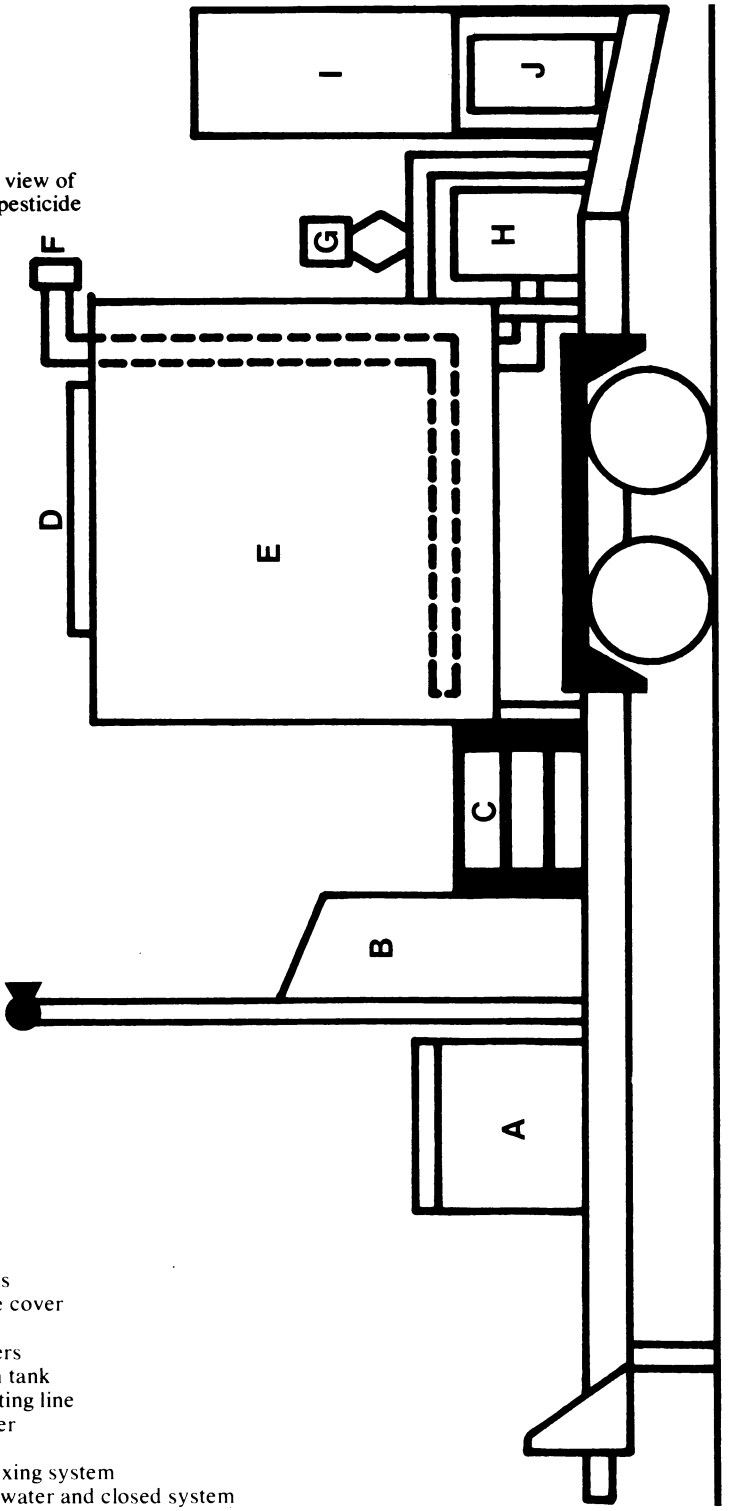
The mixing unit is simple enough for a two-man crew efficiently to provide complete ground support, including pesticide mixing and aircraft loading (figs. 1 and 2). In addition, it also contains a steam cleaner to flush the system after use, a closed pesticide mixing system to protect workers and prevent accidental spills, barrel handling equipment to facilitate formulation, tool boxes, and external lighting equipment.

In 1975, 1976, and 1977 the pesticide mixing unit was used operationally. Two people loaded premixed pesticides for three aircraft and maintained a 6-minute turnaround time for each aircraft. In 1976, the use of this system reduced the contract cost of a U.S. Department of Agriculture operation by 66 percent. Table 1 lists the equipment needed for this mixing system.

Table 1.—*Equipment needed for the trailer-mounted pesticide formulation system*

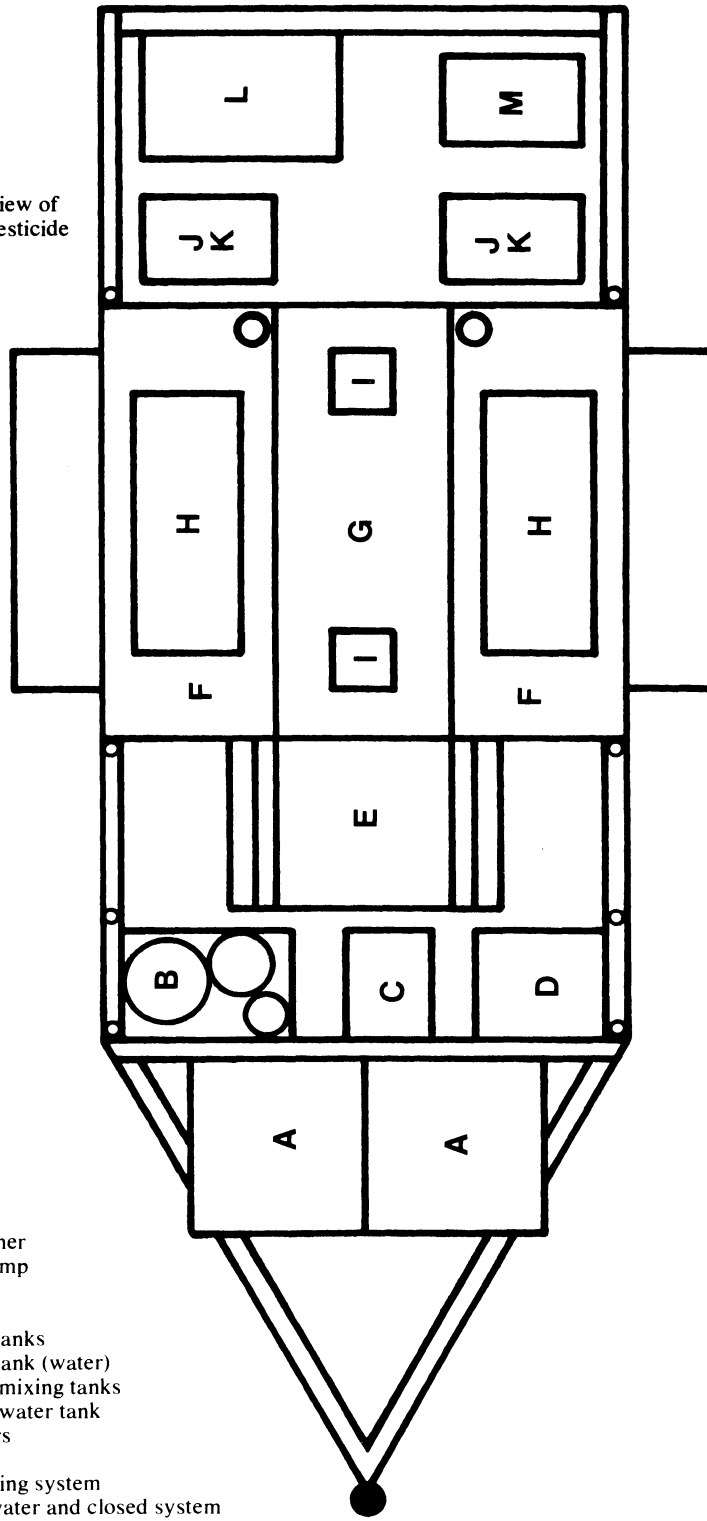
1. Trailer—General Eager Beaver®, Model-AP8
   Capacity—8,000 lb
   Bed length—12 ft
   Bed width—74 in
2. Meters—Neptune, Model 431 $1^1/_2$ in
3. Pumps, Peabody Barnes®, Model 4CCG, 3.0 hp at 3,600 rpm, cast iron, self-priming, centrifugal
4. Generator—gas-operated with capacity of 2,400 W
5. Steam cleaner—Malsbury®, kerosene fired, electrically driven
6. Mixing tanks (2)—300 gal, stainless steel (built to specification)
7. Water tank (1)—400 gal, stainless steel, with two covers for filling (built to specification)
8. Closed mixing system—Soilserv®, unit with three-material inlets (includes barrel probes and wettable powder box)
9. Vacuum unit—gas driven (for operating mixing system)
10. Valves—one-quarter turn, quick shutoff type (on all circulating lines)
11. Hose—oil-delivery type
12. Strainers (2)—50 mesh (to strain material before it is loaded in aircraft)
13. Hose connectors—cam-lock type
14. Tool boxes (built to specification)
15. Screw jacks—for leveling and stabilizing trailer

Figure 1.—Side view of components of pesticide mixing trailer.



A. Tool boxes
B. Protective cover
C. Platform
D. Tank covers
E. 300-gallon tank
F. Recirculating line
G. Flow meter
H. Pump
I. Closed mixing system
J. Pump for water and closed system

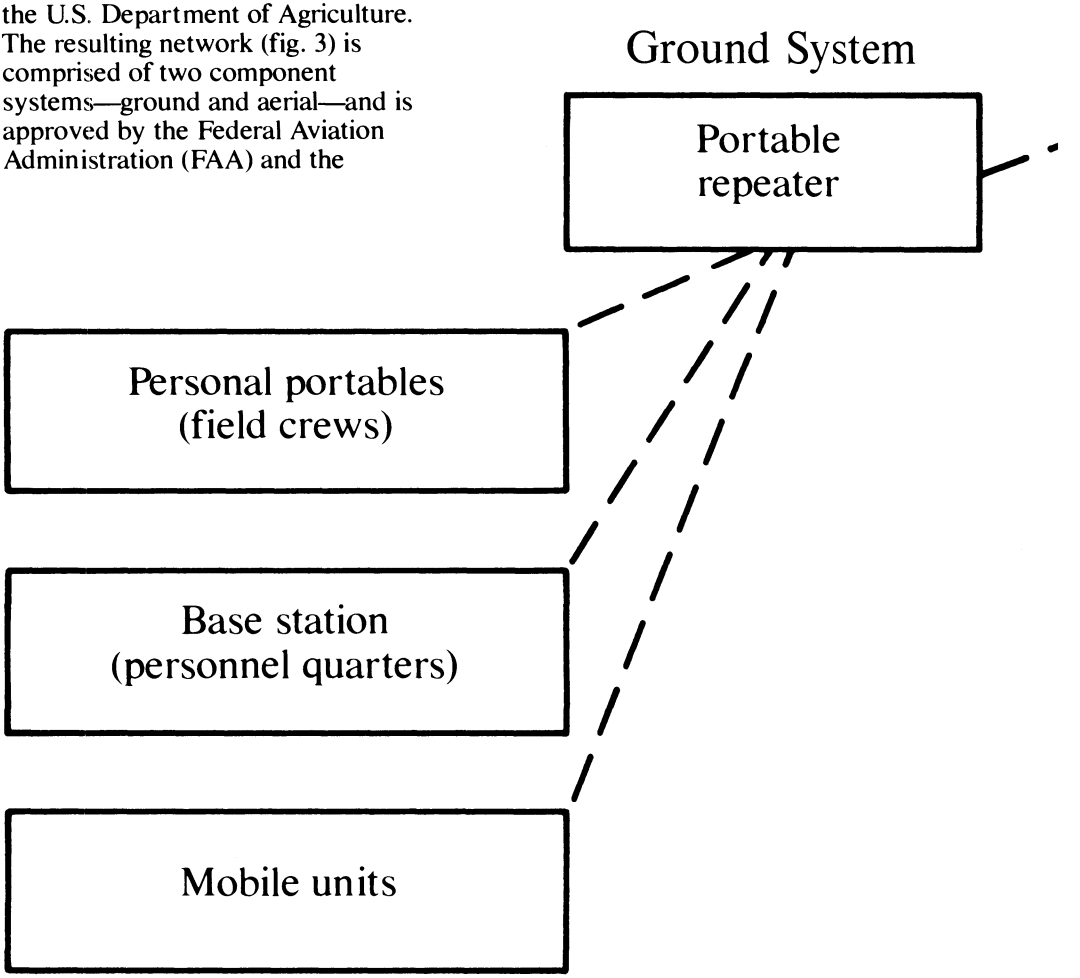
Figure 2.—Top view of components of pesticide mixing trailer.



A. Tool boxes
B. Steam cleaner
C. Vacuum pump
D. Alternator
E. Platform
F. 300-gallon tanks
G. 400-gallon tank (water)
H. Covers for mixing tanks
I. Covers for water tank
J. Flow meters
K. Pumps
L. Closed mixing system
M. Pump for water and closed system

A Communication Network

The efficiency, safety, and overall success of aerial application of pesticides are often dependent upon good communication among participating personnel. The research and development of a workable communication system are the cooperative efforts of the Forest Service, the Animal and Plant Health Inspection Service (APHIS), and the Electronics Center at Beltsville, Md., all part of the U.S. Department of Agriculture. The resulting network (fig. 3) is comprised of two component systems—ground and aerial—and is approved by the Federal Aviation Administration (FAA) and the Federal Communications Commission (FCC). The network frequencies are also approved for use near the Canadian border by the Canadian Department of Communication Regulation.



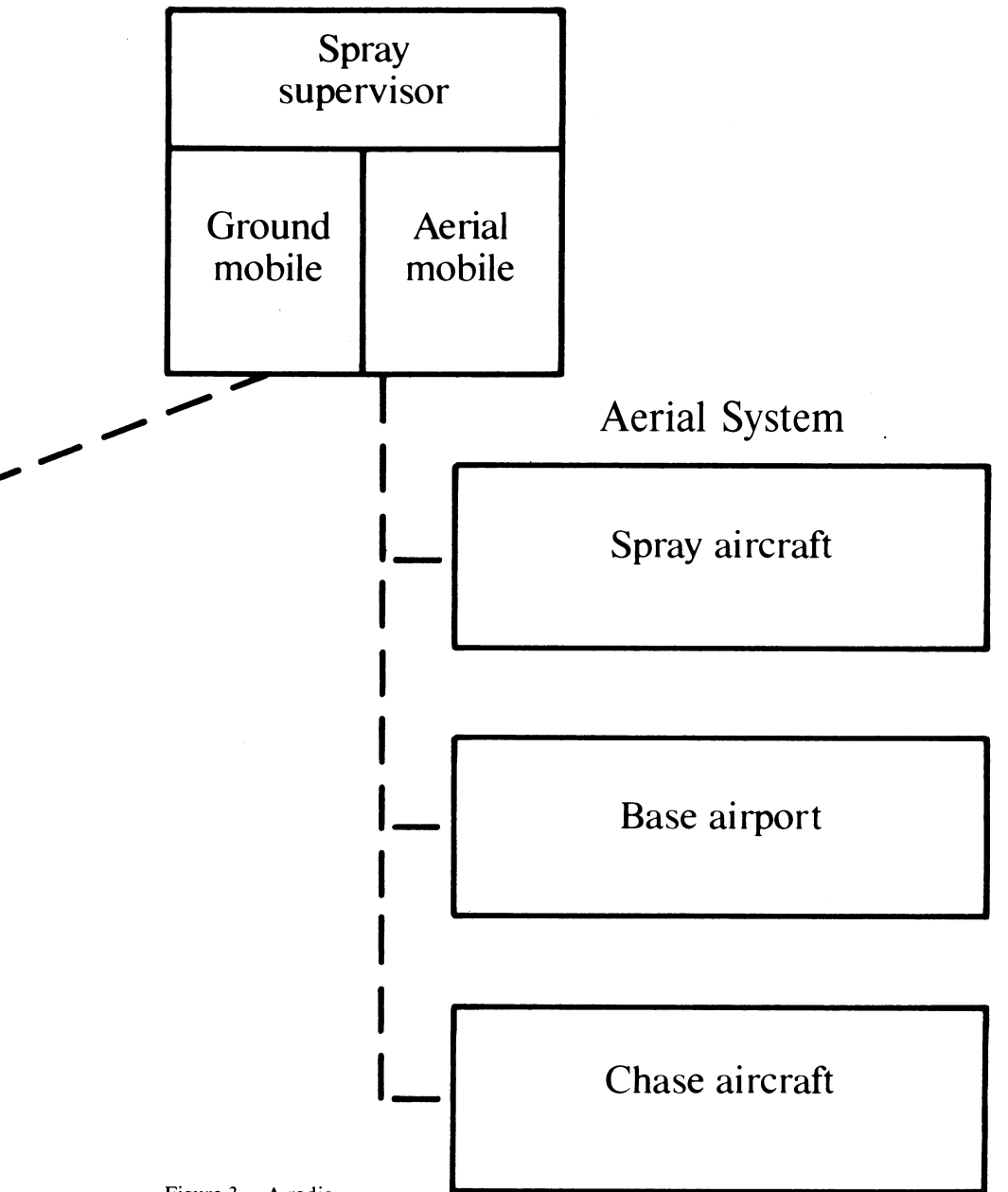


Figure 3.—A radio communication network for aerial pesticide application operations.

Ground System

The ground system permits communication among personnel in the spray blocks, at the airport, in project vehicles, and with cooperating agencies using compatible frequencies. The keystone of the ground system is a portable repeater, which increases the operating range of the radios by amplifying and transmitting the radio signals from ground equipment with a range otherwise limited to line-of-sight transmission. The other components of the ground system are a base radio, mobile radios, and personal portable radios (table 2). A useful feature of the mobile units is an automatic scanning mode, which permits simultaneous monitoring of all frequencies within the ground system. Six radio frequencies are available for use within the ground system (table 4). Four are assigned to the Forest Service, and two are assigned to APHIS. The interagency communication ability of the system facilitates cooperative aerial spray operations.

Table 2.—*Ground system components*

1. Repeater—General Electric Lookout®, 12 V d.c.
   a. Duplexer—Motorola® Model T-1487-8
   b. Tower—crank-up type, 75 ft
   c. Antenna—Phelps-Dodge®, Model TDD6075A, 6 dB gain
   d. Power source—Radio Shack Micronta®, 12 V d.c.

2. Base radio—Motorola Consolette® (with automatic scanning), 12 V d.c. or 110 V a.c.
   a. Tower—section type, 30 ft
   b. Antenna—Phelps-Dodge®, omnidirectional

3. Mobile radios (2)—Aerotron® Model MPAC-6 (with automatic scanning), 12 V d.c., with standard antenna

4. Personal portable radios (5)—I.E.C. Corp.®, Model LE-100, 9.6 V d.c.
   a. Rechargeable nickel-cadmium type batteries—I.E.C. Corp.®
   b. Carrying case—I.E.C. Corp.®
   c. Battery charger—I.E.C. Corp.®

Aerial System

The aerial system permits communication among the project aircraft, FAA facilities (including the base airport), and the project supervisor (table 3). Because the latter has sole communication between both the aerial and ground systems, the network permits pilot communication without interference from ground and crew chatter. Ten radio frequencies are available for use within the aerial system (table 4).

The radio communication network not only expedites many of the ground activities but also serves to increase quality of aerial application. For example, missed areas in spray blocks can be located by ground crews; spray pilots can then make remedial applications. This communication network is also a valuable safety aid. Without modification, the network can immediately function in emergency air rescue and ground evacuation should any aircraft crash or require emergency assistance.

Table 3.—*Aerial system components*

1. Mobile radios (2)—Radair®, Model 10B, 10 channel, 12 V d.c. a. Antenna—aircraft type b. Vehicle mounting bracket c. Microphone d. Crystals	2. Standard equipment used by aircraft in normal air operations

Table 4.—*Assigned frequencies*

Ground			
Channel	Transmit	Receive	
1	168.70		FS simplex[1]
2	170.975	168.70	FS repeater[2]
3	170.450		APHIS simplex
4	170.425		FS simplex
5	170.525		APHIS simplex
6	168.625		FS simplex (nationwide fire and aircraft)

Air

Channel	Transmit Receive	
1[3]	122.900	Agriculture, air to air
2[3]	122.950	Agriculture
3[3]	122.925	Natural resources
4[4]	122.800	Local airports
5[5]	123.000	Local airports
6 thru 8	Assigned frequencies of local airports with tower control	
9	122.500	Nationwide tower monitoring frequency
10	126.200	Nationwide military tower control

[1] The simplex system is a transceiver using the same frequency for transmit and receive and has a limited range.
[2] The repeater system uses different frequencies to transmit and receive. This enables the repeater to receive from portable units on 170.975, boost the signal, and transmit on 168.70 to another portable unit. This configuration increases the effective range of all units.
[3] These frequencies are used exclusively for the aerial spray operations.
[4] UNICOM (aeronautical advisory service) for airports without a control tower or flight service.
[5] UNICOM (aeronautical advisory service) for airports with control tower and flight service.

Aircraft Mount for Small-Format Camera

There has been a need for a simple, inexpensive, and lightweight alternative to the sophisticated aerial photographic equipment used to document insect defoliation. The mount developed recently is a modification of existing technology and can accommodate 35mm, 70mm, or $2^{1}/_{4} \times 2^{1}/_{4}$ in formats.

The camera platform is constructed of layers of fiberglass cloth and resin. Mounting brackets and plates are constructed of aircraft-type aluminum, and the handle is made of a $^{3}/_{8}$ in aluminum rod. Figure 4 shows a diagram of the mount.

Adapting an aircraft for the camera

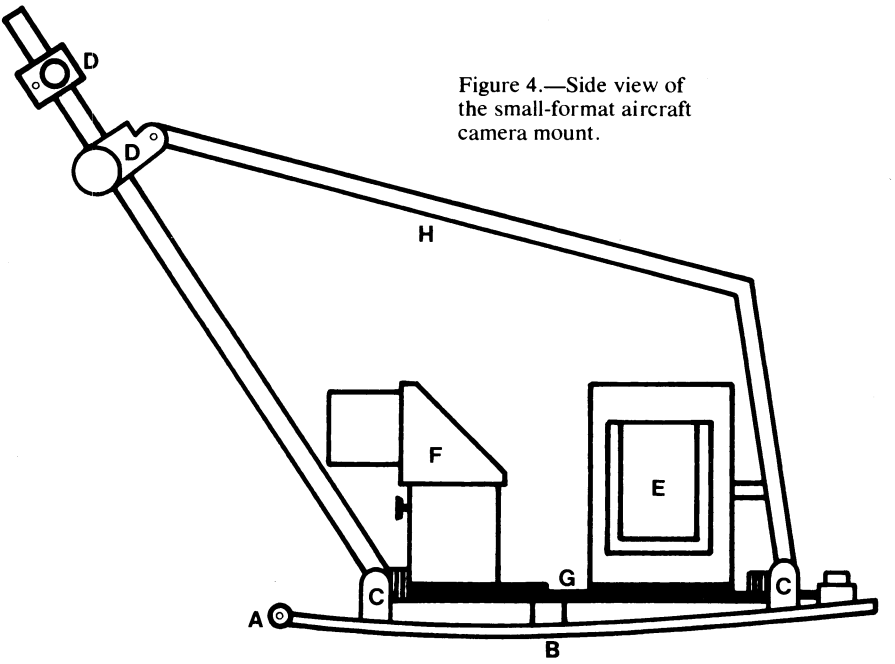


Figure 4.—Side view of the small-format aircraft camera mount.

All materials of aircraft type:

A. Piano hinge [1]
B. Fiberglass platform for camera ($11 \times 11 \times {}^{1}/_{4}$ in)
C. Outside and inside hinges for handles
D. Adjustment clamps to level mount
E. Camera attachment clamp
F. Sight (90°)
G. Crab adjustment plates
H. Handle to raise and lower mount

[1] This hinge is used to attach the mount to the airframe. Half of the hinge is bolted to the airframe and the other half is bolted to the mount base. The hinge pin is inserted or removed to secure quickly or remove the mount from the aircraft. This allows for a fast change from standard flight to photo configuration at any airport without using any specific equipment.

mount requires only slight modification of the cargo door window and no alteration of the airframe itself. Initially, a Piper Cherokee-Six 300® was chosen because it has stable flight characteristics and because the cargo door is situated behind the left wing. The camera mount was placed in the cargo door window, where it was away from engine exhaust and free of obstructions. Further investigations revealed two other aircraft with identical body configurations capable of accommodating the mount: the Piper Cherokee Lance® and the Piper Seneca II®. The latter is a light twin-engine aircraft and has the advantage of greater range.

The plane may be flown with the mount retracted, or in position for photographing (fig. 5) when a clip is placed at the top of the window hole to hold the mount secure in the horizontal position. All materials used for mount construction and aircraft modification must be FAA approved.

Figure 5.—Aircraft camera mount and small-format camera in lowered position.

Figure 6.—Color infrared photograph of pesticide-treated spray block taken by small-format camera.

The mount has been tested in two aircraft and with two different camera systems (35mm and $2^1/_4 \times 2^1/_4$ in formats). The results have shown that reliable, inexpensive, and high-quality photographs can be made for documenting insect-caused tree defoliation (fig. 6). Each of the camera formats accommodated by this mount performed equally well. As needs and purposes intensify, one format may be better suited than another.

The mount is advantageous from a safety standpoint. With the camera mounted securely and the photographer safely belted into the rear seat, there is no need for personnel to work through open aircraft doors. The mount and type of aircraft modification are approved by the FAA and the Forest Service.

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